Center Independent Research & Development: JPL IRAD

Advanced Low Temperature Thermoelectric Materials for Cryogenic Power Generation (CryoTE)

Completed Technology Project (2013 - 2016)

Project Introduction

The current state of the art thermoelectric materials for low temperatures for the past 50 years have been alloys based upon Bi2Te3 with ZT of 1.2 at 300 K. These heritage materials, although effective, are relatively inefficient at cryogenic Titan temperatures. In this project through a combination of theoretical simulations and cutting edge synthetic techniques, we will design and engineer advanced TE materials capable of efficient energy conversion in the 100 to 300 K temperature range.

In this work we will: 1) develop novel TE materials with a factor of 2x or more improvement in the dimensionless TE figure of merit (ZT) over state-of-the-art materials in cryogenic environments (100K-300K range) ; and 2) validate the novel materials performance using proof-of-concept power generation TE devices to demonstrate their potential to achieve 15 to 25% conversion efficiency (up to 4x state-of-practice systems) when using low grade heat sources, Radioisotope Heater Unit (RHU)-based or single General Purpose Heat sources (GPHS), and rejecting heat at cryogenic temperatures.

Anticipated Benefits

This technology could be utilized as power systems for Europa cryobots, Mars Long-Lived Network.

This technology is ideal for missions in cryogenic environments i.e. 90K for a Titan explorer mission, 110 K for Europa cryobots, and deep thermal cycling in the range of 145K to 300K, for the Mars Long-Lived Network. These missions have been consistently prioritized by the Planetary Sciences decadal surveys.

This technology could be utilized for thermal management applications and solid state cooling.

DOD/DOE thermal management applications. Solid-state cryo-cooling of detectors.

Advanced Low Temperature Thermoelectric Materials for Cryogenic Power Generation

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

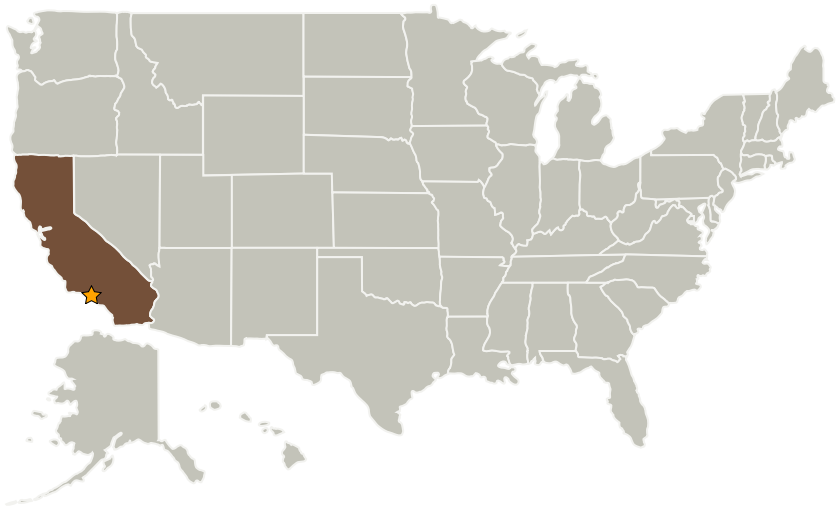
Responsible Program:

Center Independent Research & Development: JPL IRAD

Advanced Low Temperature Thermoelectric Materials for Cryogenic Power Generation (CryoTE)

Completed Technology Project (2013 - 2016)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Management

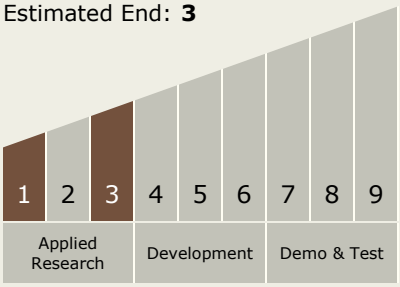
Program Manager:
Fred Y Hadaegh

Project Manager:
Jonas Zmuidzinas

Principal Investigator:
Sabah K Bux

Technology Maturity (TRL)

Start: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.1 In-space Propellant Storage & Utilization